

UNIVERSITI TEKNOLOGI MARA

**COMPARATIVE STUDY ON RFID, HOTSPOT
AND CAR PLATE SCANNING METHOD: FOR
INTELLIGENT PARKING MANAGEMENT
SYSTEM**

ISREDZA RAHMI BINTI A.HAMID
(Bachelor of Information Technology, UUM)

**Independent Study submitted in partial fulfillment of the
requirements for the degree of
Master of Science Information Technology**

Faculty of Information Technology & Quantitative Sciences

April 2005

ACKNOWLEDGEMENT

This section is provided intent to give opportunities to all the people who are willing to sacrifice their valuable time and effort in order to make this research report hundred percent successful. What could have been better ways to thank everyone who was involved in this research than putting on a special tribute page in this report, so that those who read this report will acknowledge their unbelievable effort to make this report successful.

In the name of Allah, the Most Merciful and the Most Gracious. I sincerely thank Allah s.w.t for giving me the strength, the ability and the courage to successfully complete this report. Without His guidance and blessing, I will not have the capability to finish this piece of work.

I would also wish to express my most gratitude to my lecturer, En. Ahmad Yusri Bin Dak, who is my supervisor, which has assisted me tremendously throughout this research in general and throughout completing this report in particular. His advice and visions have guided me to better understand the area of knowledge for this research.

Last but not least, I would like to express my sincere thanks to my parents who worked very hard in bringing me up. I also would like to thank to my beloved husband, my caring friends, classmates, relatives course, roommates and siblings for their second opinion and thoughts. Last but not least, I am indebted to a number of colleagues at Kolej Universiti Teknologi Tun Hussein Onn (Kuittho) for their support. This study was funded by Jabatan Perkhidmatan Awam (JPA). It is having been a very successful report indeed.

Thank you again and may Allah give all of you guidance and reward.

TABLE OF CONTENT

TITLE PAGE	i
ACKNOWLEDGEMENT	ii
TABLE OF CONTENT	iii
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF ABBREVIATIONS	ix
ABSTRACT	xi
CHAPTER 1 INTRODUCTION	
1.1 Overview	1
1.2 Background of The Research	2
1.3 Research Questions	4
1.4 Objective of The Research	4
1.5 Significance of The Research	5
1.5.1 Shopping Complex	5
1.5.2 Car Park Management Operator	5
1.5.3 Vehicle Owner	5
1.5.4 Insurance Company	6
1.5.5 People Who Are Interested To Develop Parking Management System	6
1.6 Scope of The Research	6
1.7 Limitation of The Research	6
CHAPTER 2 LITERATURE REVIEW	
2.1 Intelligent Parking Management System	8
2.1.1 Intelligent Parking Management System Issues	9
2.1.1.1 Parking Availability	9
2.1.1.2 Parking Location and Routing	10

2.1.1.3	Advantages of Intelligent Parking Management System	10
2.1.2	Intelligent Parking Management System Setup	11
2.2	Car Plate Scanning	12
2.2.1	Car Plate Scanning Process	13
2.2.2	Image Processing	16
2.2.2.1	Edge Detection	16
2.2.2.2	Threshold	17
2.2.2.3	Resampling	17
2.2.3	Car Plate Scanning Operation	18
2.2.4	Car Plate Scanning Issues	19
2.3	Wireless Fidelity (Wi-Fi)	20
2.3.1	Hotspot Application	21
2.3.2	Hotspot Issues	22
2.3.3	Hotspot Advantage and Disadvantages	23
2.3.3.1	Advantages	23
2.3.3.2	Disadvantages	23
2.3.4	Hotspot Environment	24
2.3.4.1	Size of The Location	24
2.3.4.2	Number of Users	24
2.3.4.3	Usage Models	25
2.4	The Evolution of RFID Technology	25
2.4.1	Radio Frequency Identification (RFID)	27
2.4.2	Reader	30
2.4.3	Antenna	30
2.4.4	Anti-collision	31
2.4.5	RFID Memory	31
2.4.6	RFID Data Transmission	32
2.4.6.1	Inductive Coupling	32
2.4.6.2	Electromagnetic Backscatter Coupling	32
2.4.7	Active and Passive RFID	33
2.4.8	RFID Specification	34

2.4.9	RFID Implementation	35
2.4.10	RFID Smart Card	37
2.4.11	Range Performance	38
2.4.12	RFID Standards	42
2.4.13	The Future of RFID	43
2.4.14	RFID Issues and Solutions	44
2.4.14.1	Orientation	45
2.4.14.2	Reader Coordination and Signal Processing	45
2.4.14.3	Product Packaging Independence	46
2.4.14.4	Multiple Standards	46
2.4.14.5	Longer Range	47
2.4.14.6	Lowering Manufacturing Costs	47
2.4.15	Privacy and Customer Pushback	48
2.5	Similar Research	48
2.6	Summary	50

CHAPTER 3 METHODOLOGY

3.1	Primary Data Collection	51
-----	-------------------------	----

CHAPTER 4 RESULTS AND ANALYSIS OF DATA

4.1	Results and Analysis of Data	52
4.1.1	Car Plate Scanning Method	52
4.1.2	Hotspot Technology	55
4.1.3	System Implemented RFID Technology	56
4.1.4	RFID Tags For In building Or Outbuilding Parking Environment	58

CHAPTER 5 DISCUSSION OF FINDINGS

5.1	Discussions of Findings	60
5.1.1	Car Plate Scanning Method	60
5.1.2	RFID Implementation	61
5.1.2.1	RFID Tag and Access Mode	62

LIST OF TABLES

Table Number	Page
Table 1.1: Statistic Vehicle Stolen For Year 2000-2004 (Source: http://www.rmp.gov.my/rmp03/statjsjindeks04.htm)	2
Table 2.1: Main Differences Between Barcode and RFID	27
Table 2.2: Four Basic Range of Frequencies	30
Table 2.3: Comparison Between Active and Passive RFID.	33
Table 2.4: Frequency Band and Application (Source: AIM, 2001)	39
Table 2.5: Frequencies Classified Worldwide as ISM Frequency Ranges or SRD Frequency Ranges	40
Table 2.6: Human Exposure Regulation (Source: Massachusetts Institute of Technology, 2003)	43
Table 4.1: Analysis on Car Plate Scanning Method	53
Table 4.2: Brief Description on Car Plate Scanning Method	54
Table 4.3: Key To Be Considered Before Implementing Hotspot Application	55
Table 4.4: List of System Implement RFID Technology	56
Table 4.5: Characteristic of RFID Tags Suitable For In building or Outbuilding Parking Area.	58

LIST OF FIGURES

Figure Number	Page
Figure 2.1: Typical Configuration of License Plate Recognition (LPR)	12
Figure 2.2: A Segmented “K” Character	16
Figure 2.3: Progression of Images As They Are Being Processed By Software	18
Figure 2.4: An RFID Tag, an RFID Tag With Printed Barcode and Dust-Sized RFID Microchips.	28
Figure 2.5: Tag and Reader Configuration (Source: Larsson and Qviberg, 2004)	29
Figure 2.6: 96-bit EPC Scheme (Source: Dobson, 2003)	29
Figure 2.7: Antenna	30
Figure 2.8: RFID Smart Card	37
Figure 6.2: System setup for Intelligent Parking Management System	69
Figure 6.1: Proposed Intelligent Parking Management System using RFID and hotspot technology	74
Figure 6.2: RFID Reader	75

LIST OF ABBREVIATIONS

RFID	Radio Frequency Identification
RF	Radio Frequency
Wi-Fi	Wireless Fidelity
IPS	Intelligent Parking System
VMS	Variable Message Signs
HAR	Highway Advisory Radio
MHz	Megahertz
LPR	License Plate Recognition
DLL	Dynamic Link Library
IR	Infra-Red
VLP	Vehicle License Plate
ANN	Artificial Neural Network
WLAN	Wireless Local Area Network
NIC	Network Interface Card
GPRS	General Packet Radio Service
IEEE	Institute of Electrical and Electronics Engineers
AP	Access Point
DNS	Domain Name System
VPN	Virtual Private Network
UPC	Universal Product Code
AIDC	Automatic Identification Data Capture
EPC	Electronic Product Code
LF	Low frequency
UHF	Ultra High Frequency
HF	High Frequency
VHF	Very High Frequency
ISM	Industrial-Scientific-Medical
EAS	Electronic Article Surveillance

IC	Integrated Circuit
PTS	Post och Telestyrelsen
LAN	Local area Network
CEPT	Conference of Postal and Telecommunications
CSMA	Carrier Sense Multiple Access
ISO	International Standard Organization
OCR	Optical Character Recognition
PC	Personal Computer



PTTHM
PERPUSTAKAAN TUNKU TUN AMINAH

ABSTRACT

Intelligent Parking Management System technology that enables efficient use of parking will be increasingly important as a growing population places ever-growing demands on existing transportation infrastructure. While the problems of parking shortages are well recognized, the cost of providing additional capacity is frequently prohibitive. Intelligent Parking Management System may provide a sensible means to effectively increase parking capacity, while simultaneously reducing demand by enabling parking service operators to charge market rates depending on time of day. The potential benefits of Intelligent Parking Management System are it can improve security for both car park operators and car park users, flexible access control to easily accommodate visitors and delivery vehicles, improve traffic flow during peak periods and others. The Intelligent Parking Management system using Radio Frequency Identification (RFID) and hotspot technology is the advanced parking technologies to manage existing parking spaces at a shopping complex to increase effective capacity and transit access. Smart parking systems implemented worldwide have been found to reduce delays and improve convenience of parking (Shaheen, 2003). The car plate scanning implement also can reduce vehicle stolen problem and increase the security of parking area more competently. Although this is a new technology in Malaysia, the RFID application is world wide accepted by other country. The research method is a primary data which is gathered through a literature review and on line web on RFID, hotspot and car plate scanning method. Through this research, the writer found that passive RFID tags is more cost effective than active tags. It also the most preferable tag by other researcher. Although there are some obstacles to implement RFID and hotspot technology, during investigation, the writer found that there are four solutions can be put into practice: implement reference tag to amplify the passive tag signal to have greater length of coverage, utilize hybrid RFID tag design that is protocol-compatible with existing Institute of Electrical and Electronics Engineers (IEEE) 802.11 or Bluetooth standards as well as existing Radio Frequency (RF)-tag standards, the arrangement of antenna and RFID tag and use RFID reader with Wireless Fidelity (Wi-Fi) 802.11 interface to detect RFID tag. Finally, the proposed network architecture for the Intelligent Parking Management System is designed.

CHAPTER 1

INTRODUCTION

This chapter provides the background of the study. It also gives details of the research questions, objectives, significant, scope and limitation of the study.

1.3 Overview

Increasingly, parking is becoming an important aspect of transportation planning. Many areas have seen explosive growth in the number of visitors and customers as the result of urban revitalization, uptown development and the general trend toward increased mobility of our society. As a result, localities are conducting studies on parking supply management (Louisell et al., NA).

Intelligent parking management systems are highly specific application that uses precise signing scheme that can include information on current parking inventory and parking facility locations. While entering the gate, a camera will capture picture and scan the car plate number and embedded the information into the ticket assigned to the vehicle owner. This ticket is using Radio Frequency Identification (RFID) technology. It uses a semiconductor (micro-chip) in a tag or label to transmit stored data when the tag or label is exposed to radio waves of the correct frequency. RFID is used because it is non line of sight naturally, the tags can be read in various substances such as snow, fog, ice, paint and crusted grime.

Each level install with hotspot which is used to detect empty parking slots based on the ticket assign to the vehicle owner. The vehicle owner should not bring along the ticket to the mall. If this happen, the hotspot will assign that the parking slot is empty and available to other customer. It is important to understand the hotspot environment in order to deploy a configuration that meets the users' requirements. There are three key factors that determine what type of hotspot environment to create: the physical size of the location, the number of simultaneous users, and the types of usage expected.

If they want to leave the parking, the camera will scan again the car plate number to check whether it is synchronized with the ticket given. Beside that, the car park management operator can check whether the driver is the appropriate person based on the previous picture taken.

1.4 Background of The Research

Most of the vehicle owners are facing problem to allocate parking spaces in shopping complex. They will go round looking for parking spaces and finally caught in a huge traffic jams both inside, and outside the car park. This is especially so during special events such as sales or festivals. Unfortunately to the driver if the parking rate is based on time. According to police statistic as depicted in Table 1.1, the amount of vehicle that has been stolen is increasing. This is maybe because lack of awareness from the vehicle owner and shopping complex.

Table 1.1: Statistic Vehicle Stolen For Year 2000-2004 (Source: <http://www.rmp.gov.my/rmp03/statisjindeks04.htm>)

Vehicle	2000	2001	2002	2003	2004
Lorry and van	3698	4306	4570	5551	4892
Car	7278	8520	8544	8537	8624
Motorcycle	45903	47223	47137	50212	51560

To prevent this from happen, intelligent parking management systems is developed with various features as stated above:

- i. Centralized monitoring system.
- ii. Parking Database to monitor available parking slot.
- iii. Color and Car Plate Capture, extraction or recognition.
- iv. Radio Frequency Identification (RFID).
- v. Empty space information is displayed on the monitor while entering the gate.
- vi. Hotspot is used to detect empty parking spaces by detecting RFID frequency and update it with the database so that it can preview available slot on the screen to the customer.

Centralized monitoring system is the main system of the Intelligent parking management system. This monitoring systems is used to manage and monitor others sub components of the system. All the update information is done here. The parking database records vehicles and owner detail, event log and vacancy info. If the owner forgot where they put the vehicle, they can go to the nearest kiosk available to check the vehicle's position by entering the car plate number.

Hotspot communicates with the centralized monitoring system to update the database regarding available parking spaces. It will detect based on RFID frequency. While entering the gate, a camera will capture the color and car plate number, extract it and recognize it to embed it into the ticket. The car image is capture from video stream to extract and recognize the car color and plate number using Image Processing and Neural Network. The RFID is embedded in the ticket to keep track of the vehicles in the car park. The hotspot detects the RFID signal; the parking slot is assigned as full.

The main purpose of this research is to produce comparative studies on various intelligent parking management systems. This study tries to implement hotspot and

RFID technology in parking management system, which is not yet been used by other country.

1.5 Research Questions

This research study will try to answer the following question:

“What is the specification for hotspot coverage, RFID and car plate scanning method to be implemented in the Intelligent Parking Management System?”

1.6 Objective of The Research

Aim:

To conduct a comparative review on various system implementing RFID technology.

Objectives:

- i. To identify existing Intelligent Parking Management System.
- ii. To investigate the technical specification for hotspot, RFID and car plate scanning method.
- iii. To choose and describe the specification for hotspot, RFID and car plate scanning method to be implemented in the Intelligent Parking Management System.

1.8 Significance of The Research

This research will benefit many parties. Not only to those who always engaged with the Parking Management System, this paper also will benefit vehicle owner. Among the parties that will benefit from this stuff are:

1.8.1 Shopping Complex

This research can be a guideline for shopping complex to apply intelligent parking management system using hotspot, RFID and car plate scan method. In order to achieve this, they have to setup appropriate device and software according to the specification given.

1.8.2 Car Park Management Operator

This study will guide car management operator to provide superior services. As a result, this will attract more customers and thus increase business. The public would not mind paying a little extra for these services as long as their property is protected.

1.8.3 Vehicle Owner

This research will simplify vehicle owner to find empty parking slots at a shopping complex through monitor available at the entrance. This monitor shows vacant parking. Moreover, there is an extra security because the ticket assigned is synchronizing with the car plate number. While entering the gate, a camera will recognize the plate number and embedded it into the ticket. If the owner wanted to leave, the camera will check whether the ticket is synchronize or not with the car plate number.

1.8.4 Insurance Company

This research will be valuable to the insurance company where it can reduce the amount paid to claimants arising from stolen vehicles in indoor car parks through first-class safety.

1.8.5 People Who Are Interested To Develop Parking Management System

This research will be the best reference for peoples who are interested in developing intelligent parking management system. This pioneer research implementing hotspot and RFID will be valuable data to the new investor and

1.9 Scope of The Research

This comparative study will be done on various intelligent parking management systems available around the world. This research is focusing for indoor parking such as at the shopping complex. Wrapping up this research documents is the best specification for hotspot coverage, RFID and car plate scanning method together with the best hardware and software to implement it. This research will be a good guideline to people who are interested in implementing this system.

1.10 Limitation of The Research.

Limitations of the research are:

- i. This idea is new in Malaysia. Therefore, there are lacks of information regarding parking spaces in shopping complex and intelligent parking system available.

- ii. If the vehicle owner brings the ticket to the shopping mall, the hotspot will not detect that the parking spaces has been occupied. This will cause problem to other user while searching for empty parking slot.
- iii. The vehicle owner have to put the ticket in a save place in the car. As RFID is line of sight, they can put it even under car seat.
- iv. Good maintenance is compulsory in order to manage the system accurate and precisely.
- v. The camera did not capture the driver face clearly. This will cause problem to the car management operator to detect whether the driver is legal or not.



PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

CHAPTER 2

LITERATURE REVIEW

The literature is a valuable resources and an important storehouse of knowledge and thinking about a topic or area. This chapter will discuss more about all of the information related to the research study. It covers the research on Intelligent Parking Management system available, hotspot and RFID technical specification and car plate scanning method.

The literature review in this paper is based on books, journal articles, on-line documents and web search covering the areas on Intelligent Parking Management system available, hotspot and RFID technical specification and car plate scanning method.

2.7 Intelligent Parking Management System

With decreasing parking supply and increasing enrollment and shopping complex staff numbers, they are beginning to realize the importance of properly allocating available parking. Intelligent Parking Management Systems can provide the positive guidance necessary to help shopping complex's customers find available parking quickly and safely. It is common for the owner of a vehicle to take a ticket at the entrance of a car park or insert a membership card. The ticket or the card allows the driver to enter.

There are many studies regarding Intelligent Parking System Crowder and Walton (2001) provide technical report on Intelligent Parking System (IPS) for the University of Texas reallocates parking and reduce congestion and illegal parks. It provides university way finding, which can complement IPS. Variable Message Signs (VMS) have been considered by the university to provide way finding and parking information.

2.7.1 Intelligent Parking Management System Issues

Intelligent parking management solutions can take on a range of configurations based on the specific problem being addressed. According to Louisell et al. (2005) in general, the parking problems can break down into two broad categories: lack of information on the availability of parking spaces at a specific location and lack of information on what facilities are available and what is the best routing to get to them.

2.7.1.1 Parking Availability

Systems are deployed to continuously monitor the number of available spaces at each participating parking facility. This information is fed to a centralized computer that generates messages for deployment through any number of media ranging from general broadcast media services to highly specific messages to specific addressees. The messages can be delivered to parking patrons via the worldwide web, specialized TV stations, Highway Advisory Radio (HAR) systems, VMS devices, subscription e-mail services or potentially to onboard navigation systems and in-vehicle signing systems installed in privately-owned autos. Parking information provided in these formats can be useful in pre-trip planning and reroute to the attraction to be visited.

2.7.1.2 Parking Location and Routing.

Information systems are populated with data on the location of parking facilities, the number of spaces they have, the hours of operation, the cost of parking, nearness to major attractions and directions from major points of access. This information can be accessed in pre-trip planning via the worldwide web or can be included in onboard navigation system or in-vehicle signing system packages. In addition, this information can be embedded in effective signing concepts that provide en-route travelers with trailblazer information as they approach major attractions.

2.7.1.3 Advantages of Intelligent Parking Management System

Listed below are the advantages of implementing Intelligent Parking Management system:

- i. Can be used to double check that the car is allowed to cross and shorten the time it takes to go through the border, so shortening the typical long queues.
- ii. Car park control and management using automatic license plate recognition.
- iii. Access control to authorized users at staff car parks and sensitive sites.
- iv. Maintain current and historical record of vehicles on parking slot.
- v. Improved security for both car park operators and car park users.
- vi. Flexible Access Control to easily accommodate visitors and delivery vehicles.
- vii. Can improve traffic flow during peak periods.
- viii. Car park usage analysis for management purposes.
- ix. Benefits to the traveler are increased ease of access, reduced time spent looking for parking, and reduced frustration.

2.7.2 Intelligent Parking Management System Setup

In order to take photographs of the car plates, the digital camera was placed in front of the car at one meter away from the front of the car and at a height of 0.5 meter (Chanson & Robert, 2002 and Alias & Mohamad, 1999). Photographs were taken under varying weather conditions ranging from imminent rain and cloudy sky through to very sunny. Some license plates were dirty or damaged while some were very clean.

The Intelligent Parking Management system was carried out by Chanson and Roberts (2002) used Intel Pentium III 733 MHz processor, 256 MB SDRam PC133, a 15 GB 7200 rpm hard drive and a 32 MB TNT2 AGP video card. The photographs that were taken with a Sony digital Mavica MVC -FD71 were 640 pixels wide and 480 pixels high. The software was developed using Borland Delphi 5.

Hoffman (2004) proposed License Plate Recognition (LPR) systems consist of the following units:

- i. Camera - Take the images of the car (front or rear side)
- ii. Illumination - A controlled light that can bright up the plate and allows day and night operation. In most cases the illumination is Infra-Red (IR) which is invisible to the driver.
- iii. Frame grabber - An interface board between the camera and the PC that allows the software to read the image information.
- iv. Computer - A PC running Windows or Linux. It runs the LPR application which controls the system, reads the images, analyzes and identifies the plate, and interfaces with other applications and systems.
- v. Software - The application and the recognition package. Usually the recognition package is supplied as a Dynamic Link Library (DLL).

- vi. Hardware - various input or output boards used to interface the external world such as control boards and networking boards.
- vii. Database - The events are recorded on a local database or transmitted over the network. The data includes the recognition results and the vehicle or driver-face image file.

The following illustration in Figure 2.1 shows a typical configuration of a LPR system. The application runs on Windows application platform in the PC and interfaces to a set of camera or illumination units which are interfaced by the frame grabber. The application controls the sensors and controls via an input output card that is connected through a terminal block to the inputs and outputs. The application displays the results and sends them via serial communication and via DDE messages to other application. It writes the information to local database or to optional remote databases.

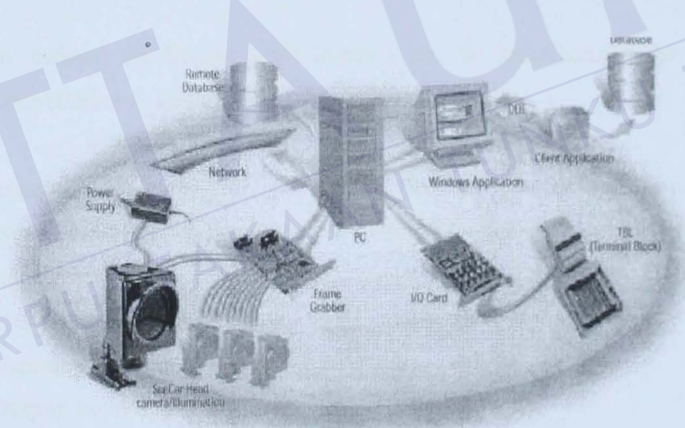


Figure 2.1: Typical Configuration of License Plate Recognition (LPR)

2.8 Car Plate Scanning

In order to monitor entering and exiting cars in parking lots and to discharge automatically in toll roads, researches of license plate recognition has been activated.

According to Alias and Mohamad (1999) automated car plate recognition generally divided into four important parts: image capturing, image preprocessing, plate number location and recognition. The recognition process can be divided into the segmentation process and the recognition process of each character (Sato et al., NA). License plate recognition (LPR) involves image capture, image processing and character recognition (Chanson & Robert, 2002).

The most of conventional segmentation methods are rule-based methods utilizing for the specific placement of the characters, labeling, histogram, and so on. In the methods, for handling with unevenness of the color depth depending on the lighting condition and the dirtiness, the binarization process is more important than the other process. The image car was capture according to: distance between the camera and the car, height of the camera, rear part of the car and angle of the camera.

The basic method for license plate location can be described by the following pseudo-code (Parker & Federl, 1996):

- i. Input: original image
- ii. Preprocessing (RGB conversion/smoothing)
- iii. Edge detection
- iv. Location of characters
- v. Genetic algorithm to find the license plate
- vi. Output: bounding box with the best score (from GA)

2.8.1 Car Plate Scanning Process

The recognition process can be divided into the segmentation process and the recognition process of each character. The most of conventional segmentation methods are rule-based methods utilizing for the specific placement of the characters,

labeling, histogram and others. In the methods, for coping with unevenness of the color depth depending on the lighting condition and the dirtiness, the binary process is more important than the other process. Nevertheless, if a noise such as a dust and a stain exists on or near a character, the character is being broken off and is segmented to too large or small area in segmentation process. This miss-segmentation is reason for decreasing of the recognition rate (Sato et al., NA).

Sato et al. (NA) experiment two method of car plate scanning method: histogram based method and artificial neural network method. In general, the images shot without an additional lighting are dusky and weak-contrast. The histogram-based method consists of the following procedure: binarization, elimination of noise outside plate and upper characters, elimination of noise by labeling and detecting of each character area by the horizontal and vertical histograms. The proposed network-based method is composed of artificial neural networks corresponding to each digit of the serial numbers. They proved that touching characters and noisy characters are often missegmented in the histogram-based method. On the other hand, the network-based method can segment even for those characters.

Brad (2002) reported a simple method for detecting the license plate form a grayscale image and recognizes the string contained by the plate. They use a preprocessing stage, consisting of a certain number of transforms established heuristically for this specific type of images. The plate rectangle is then detected, using the Hough transform for locating lines and a template for the expected rectangular form. After appropriate character segmentation, the recognition stage is based on a template matching method. The template-matching algorithm implements the following steps:

- i. Select the character image from the detected string.
- ii. Rescale the image to the size of the first template.
- iii. Compute the matching metric.
- iv. Store if highest mach found.

REFERENCES

AIM. (2001). Shrouds of Time The history of RFID

Alias, M. A., & Mohamad, D. (1999). Car plate location using coefficient of variation approach. Proceeding: The first national conference on AI application in industry, 9-15.

AMB Property Corporation. (2004). Rfid: rapidly falling industrial demand?

Auto-ID Center. (2003). Technical Report 13.56 Mhz ISM Band Class 1 Radio Frequency Identification Tag Interface Specification: Candidate Recommendation.

Brad, R. (2002). License plate recognition system.

Bridgelall, R. (2001). Bluetooth/802.11 protocol adaptation for RFID tags.

Chanson, D., & Roberts, T. (2002). License plate recognition system.

Chatterjee, R., Park, S., & Choi, J. (2004). Evaluation Of Using RFID Passive Tags For Monitoring Product Location / Ownership

Dobson, J. (2003). 50 ideas for revolutionizing the store through RFID.

Furness, A. (2001). Radio Frequency Identification RFID: A Basic Primer

Grajales, D. (2003). Selecting Equipment. Dynasys Technology Inc.

Hammond, J., Kessler, B., Meyer, G., Rivero, J., Skinner, C., & Sweeney, T. (2004) wireless hotspot deployment guide

Hayashi, H., Tsubaki, T., Ogawa, T., & Shimizu, M. (2003). Asset tracking system using long-life active RFID tags. Vol. 1.

Hennig, J. E., Ladkin, P.B., & Sieker, B. (2004). Privacy enhancing technology concepts for RFID technology scrutinized.

Hockenbrocht, D. (2004). Radio frequency identification: Tracking its developments. Vol. 1.

Ingberg, L. (2004). RFID.

Larsson, B., & Qviberg, O. (2004). Evaluation and justification of an RFID implementation - Pilot at IKEA Customer Distribution Centre.

Lee, J. C. M., Wong, W. K. & Fong, H. S. (1999). Automatic character recognition for moving and stationary vehicles and containers in real-life images.

Louisell, C., Rephlo, J. & Newton, D. (NA). Case studies in advanced parking management: The U.S. experience.

Martin, F., & Borges, D. (2003). Automatic car recognition using a partial segmentation algorithm.

Ni, L. M., Liu, Y., Lau, Y. C., & Patil, A. P. (2004). LANDMARC: Indoor location sensing using active RFID.

Oz, C., & Ercal, F. (2005). Vehicle license plate recognition using artificial neural networks

Parker, J. R., & Federl, P. (1996). An approach to license plate recognition.

Polis Diraja Malaysia. (NA). Statistik jenayah indeks. Retrieved February 24, 2005 from <http://www.rmp.gov.my/rmp03/statisjindeks04.htm>

Radio frequency identification (RFID). (2001)

Sarma, S. E., Weis, S. A. & Engels, D. W. (2003). Radio-frequency identification: security risks and challenges. Vol. 6.

Sato, S., Fujiyoshi, H., Umezaki, T., & Kanade, T. (NA). Segmentation and recognition of serial numbers in license plate.

Scher, B. (2004). ISO 15693 and What It Means for You.

Science Applications International Corporation. (2002). Chassis Identification Technology Project.

Schmidt, A., & Gellersen, H. W. (2000). Enabling implicit human computer interaction A wearable RFID-tag reader.

Senkowski, R.M., DeSilva, E., & Dombrowsky, T. (2002). Wi-Fi-802.11 The Shape Of Thing To Come.

Shaheen, S.A. (2003). Applying integrated ITS technologies to Parking management systems: A transit-based case study in the San Francisco bay area

Singer. (2003) Understanding RFID – A Practical Guide For Supply Chain Professionals.

Song, M. (2004). Connecting societies and markets: Communication technology, policy and impacts: The emerging business models in broadband-based fixed-mobile convergence era.

Want, R. (2004). The magic of RFID. Vol. 2.

Hofman, Y. (2004). License Plate Recognition - A Tutorial.

Improving Bus Terminal Management using RFID Automatic Vehicle Location (AVI) System. (NA). Retrieved on March 25, 2005 from <http://aimglobal.org/technologies/rfid/casestudy/busterminal.htm>

The Swiss Federal Railway Cuts Costs and Increases Efficiency with RFID. (NA). Retrieved on March 25, 2005 from <http://aimglobal.org/technologies/rfid/casestudy/swissrailway.htm>

Whitepaper-active passive RFID. (2002). Retrieved on March 7, 2005 from http://www.autoid.org/2002_Documents/sc31_wg4/docs_501-520/520_18000-7_WhitePaper.pdf

Ultra high frequency. (NA). Retrieved on March 7, 2005 from <http://rfidusa.com/superstore/index.php?cPath=73&osCsid=4289b0d3a10484700147c762db6b749b>